A REVISION OF *LOCHKOVELLA* CHLUPÁC, 1972 (ARTHROPODA: TRILOBITA) AND A SPECIES FROM LILYDALE AND TYERS. PHACOPIDAE OF VICTORIA, PART 5.

A. C. SANDFORD

School of Earth Sciences, University of Melbourne, Victoria, 3010, Australia. E-mail address: andrewsandford@hotmail.com

SANDFORD, A. C., 2004:12:04. A revision of *Lochkovella* Chlupác, 1972 (Arthropoda: Trilobita) and a species from Lilydale and Tyers. Phacopidae of Victoria, Part 5. *Proceedings of the Royal Society of Victoria* 116(2): 207-220. ISSN 0035-9211.

The trilobite *Acaste longisulcatus* Shergold, 1968 was described from the Early Devonian Humevale Siltstone at Lilydale, Victoria. However the holotype, an internal mould of a pygidium, is recognised as belonging to a phacopid rather than an acastid trilobite. As the original description was largely based on the paratypes, since redescribed as *A. lokii* Edgecombe, 1993, the holotype and its species have been poorly understood. The species is assigned here to *Lochkovella* Chlupác, 1972, not previously recorded in Australia but well represented by *L. longisulcata* and three other species from Victoria and New South Wales. The relationships of *Lochkovella* are reviewed, and a revised generic diagnosis is provided. *Lochkovella longisulcata* is abundant in the middle horizons of the Humevale Siltstone at Lilydale and in the upper horizons of the Boola Formation at Coopers Creek and Tyers. The stratigraphic ranges of *L. longisulcata* and 15 other trilobite and brachiopod taxa common to the Tyers and Lilydale sequences suggest correlation of the fauna from the upper horizons of the Boola Formation with faunas from the 1 700 m – 2 400 m interval of the Humevale Siltstone at Lilydale. Age estimates on these sequences are not well constrained and range within the early Lochkovian to earliest Pragian interval, accommodating divergent interpretations of the upper boundary of the Boola Formation with the overlying Coopers Creek Limestone.

Keywords: Trilobites, Phacopidae, Systematics, Victoria, Devonian

TRILOBITES occur in abundance in the marine fauna of the Late Silurian-Early Devonian Humevale Siltstone (3 800 m thick) at Lilydale, 35 km E of Melbourne (Fig. 1). Twenty-nine trilobite species, mostly undescribed, are represented by 750 specimens from about 50 different localities between Christmas Hills (35 km ENE of Melbourne) and Lilydale, ranging variously throughout the unit (Fig. 2). A poorly documented phacopid, assigned below to *Lochkovella* Chlupác, 1972, occurs at localities at horizons between 465m and 2 400 m above the base of the unit. Occurrences of the species include locality PL1820 (G20 *'Ruddocks Quarry'*), Chirnside Park (600 m horizon) and locality PL1804 (G4, *'Flowerfield Quarry'*), Coldstream (1755 m horizon). Specimens from the latter locality were figured by McCoy (1876) as *'Phacops (Portlockia) fecundus* Barrande, 1846'. The former locality is the type locality for several trilobite species including *'Goldius' grecnii* Chapman, 1915, *Sthenarocalymene angustior* (Chapman, 1915), *Acastella frontosa* Shergold, 1968 and the problematic *Acaste longisulcatus* Shergold, 1968. The latter species is not an acastid; Holloway & Neil (1982) noted that the pygidium figured by Chapman (1915) as *'Phacops crossleii* Etheridge & Mitchell, 1896' and later designated holotype of *A. longisulcatus* is a phacopid. The paratypes of *A. longisulcatus* (from PL1850 [G50, *'Black Springs Quarry'*], Chirnside Park) are not conspecific with the holotype; they belong to an acastid trilobite and were described as *Acaste lokii* Edgecombe, 1993. As the specimens of *Lochkovella* from PL1820, from PL1804 (including some of McCoy's figured specimens) and other localities are conspecific with the holotype of *longisulcatus*, they permit the redescription of *L. longisulcatus*.

Philip (1962) described a trilobite fauna from the Boola Formation at Tyers, about 130 km ESE of Melbourne, including *Cheirurus (Cheirurus)* sp. occurring at the stratigraphically lowest trilobite locality, with *C. (Crotalocephalus) silverdalensis* Etheridge & Mitchell, 1917, *S. augustior* and *Leonaspis bispinosa* Philip, 1962 occurring in the upper horizons of the unit. Philip did not record any phacopid trilobites in the Tyers fauna, but in his and other fossil collections from the area two species are represented, *Boeckops* sp. and *Lochkovella longisulcata*, the latter also occurring in the unit at Coopers Creek, about 20 km NNE of Tyers. Other trilobites occurring in the Boola Formation at

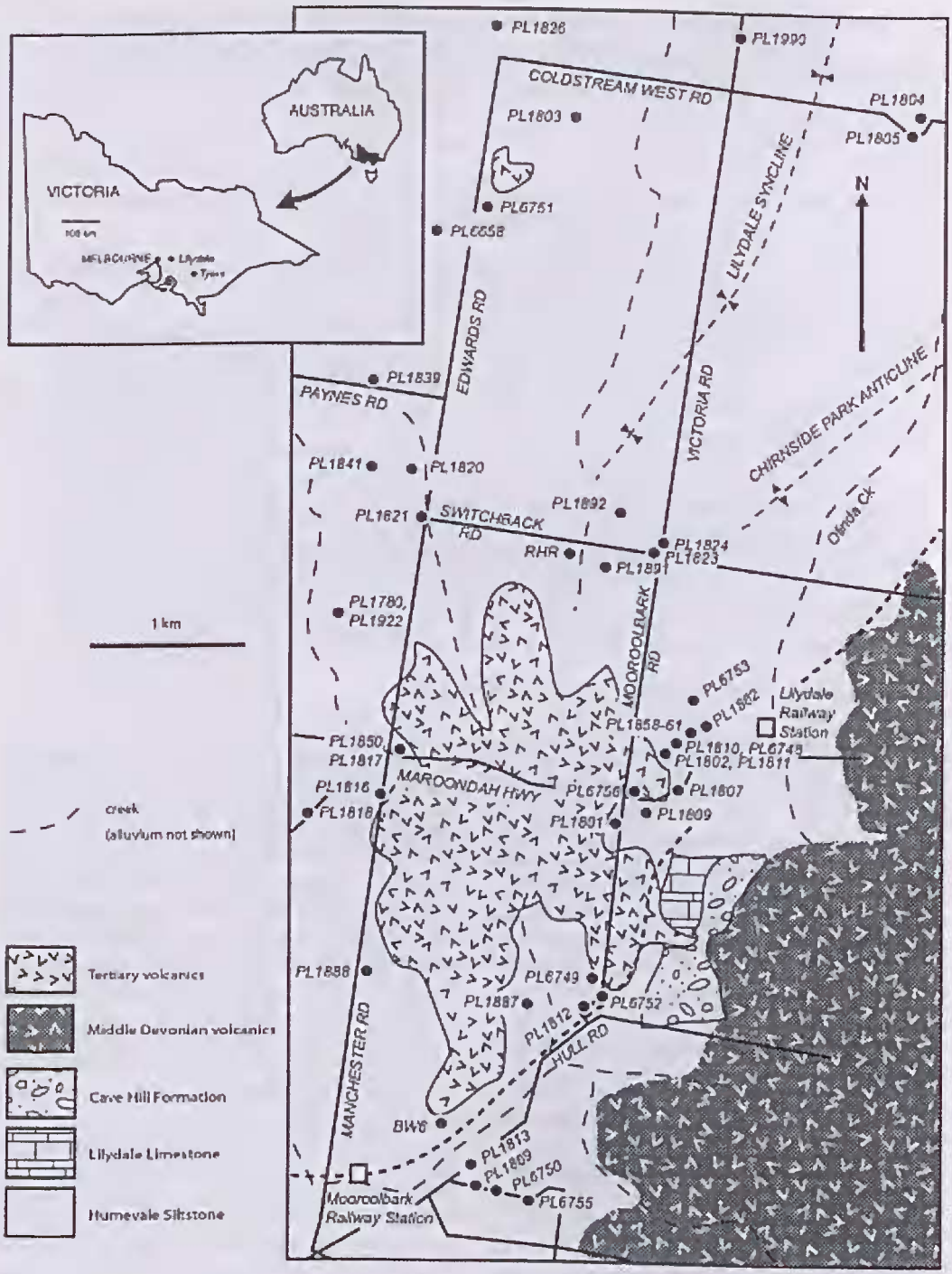


Fig. 1. Fossil localities in the Lilydale area. Geology follows VandenBerg (1970), Garratt (1972) and Wall et al. (1995). AMG gridlines and coordinates shown.

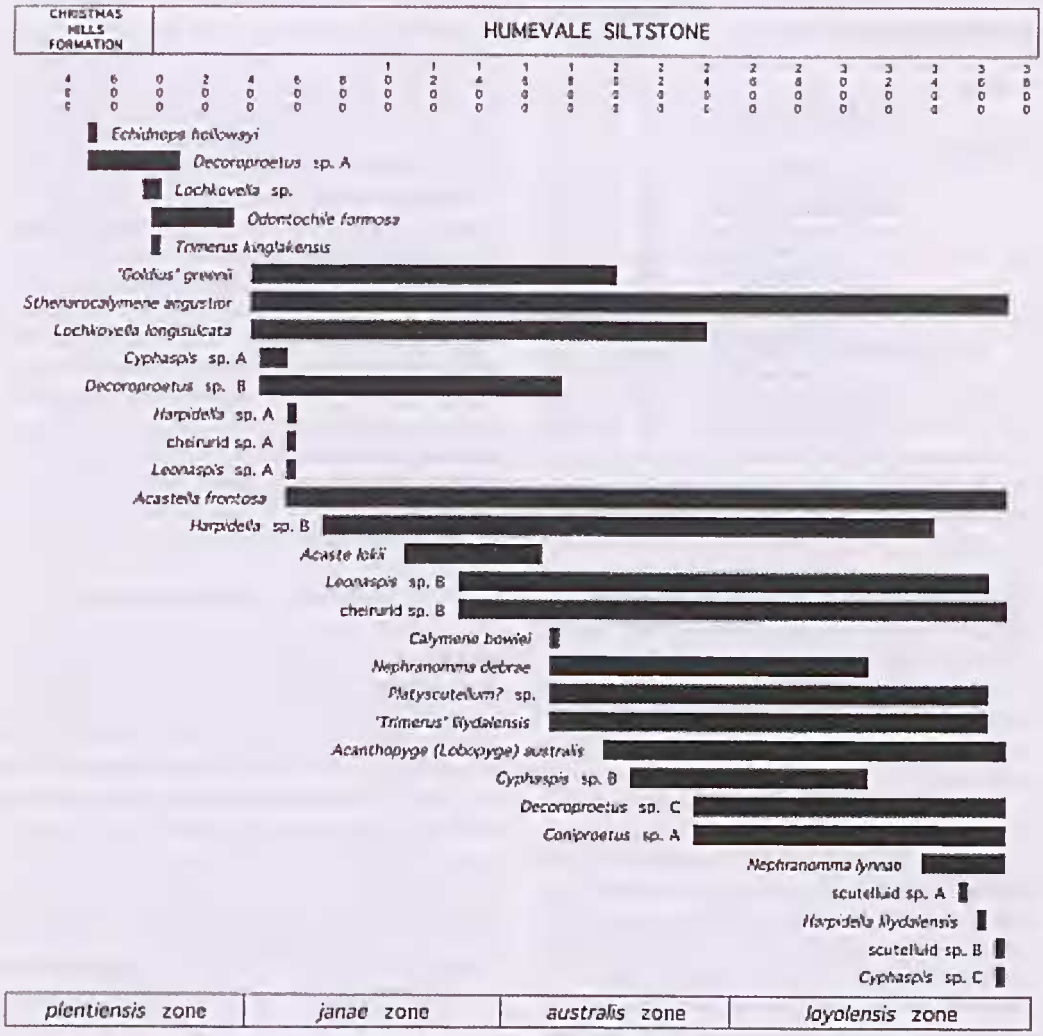


Fig. 2. Stratigraphic distribution of trilobites from the Christmas Hills-Lilydale sequence, in order of first appearances.

Coopers Creek include *S. angustior*, *'Goldius' cresswelli* Chapman, 1915, *Dicranurus* sp. and indeterminate proetid, aulacopleurid and lichid species.

BIOSTRATIGRAPHY, CORRELATION AND AGE

The trilobite fauna of the Humevale Siltstone occurs with an abundant brachiopod fauna, represented by at least 75 species (Garratt 1983: Fig. 5) and spanning four of the brachiopod assemblage zones described by Garratt (1983) and Garratt & Wright (1988) including the *Notoparmella plentiensis* Assemblage Zone (ranging up to the 400 m horizon), the *Boucotia janae* Assemblage Zone (ranging from the 400 m to the 1 500 m horizon), the *Boucotia australis* Assemblage Zone (ranging from the 1 500 m to the 2 500 m horizon) and the *Boucotia loyolensis* Assemblage Zone (ranging up from the 2 500 m horizon). Deriving age constraints from various brachiopod taxa and from graptolite, dacryoconarid and conodont faunas from other areas, Garratt & Wright correlated the base of the *janae* zone with the Siluro-Devonian boundary, and correlated the *australis* zone with the late Lochkovian *Monograptus*

Brachiopod and trilobite taxa represented in the upper Boola Siltstone at Tyers	Stratigraphic range at Lilydale (metres above base of Humevale Siltstone)		
TRILOBITES			
Lochkovella longisulcata	465	to	2400
Sthenarocalymene angustior	465	to	3800
BRACHIOPODS			
Lissatrypa lenticulata	50	to	3720
Plectodonta bipartita	300	to	3620
Cymostrophia euglyphoides	465	to	3720
Straphonella gippslandica	465	to	2600
Eospirifer easoni	500	to	3720
Spinatrypa fimbriata	540	to	3800
Notoleptaena clophera	560	to	3720
Maorestrophia kablei	600	to	3800
Boucotia australis	1150	to	3620
'Strophochonetes' cresswelli	1500	to	3720
Notanoplia philipi	1600	to	2960
Hysterolites lilydalensis	1700	to	3800
Schizophoria sp. nov. A.	1700	to	3720
Leptostrophia affinitata	2580	to	3720

Fig. 3. List of trilobite and brachiopod taxa common to the Tyers and Lilydale sequences, and their stratigraphic ranges at Lilydale.

hercynicus graptolite Biozone. They correlated the base of the *loyolensis* zone with the Lochkovian-Pragian boundary; although elsewhere Garratt (1983: 86) assigned the lower horizons of the *loyolensis* zone at Lilydale to the late Lochkovian. From these age estimates, *L. longisulcatus* ranges through the early and late Lochkovian, but excluding the earliest and latest Lochkovian.

The lithology and fauna of the Boola Formation were described in detail by Philip (1962). Problems regarding the nomenclature and correlation of strata currently referred to the Boola Formation and the overlying Coopers Creek Limestone were discussed by Mawson & Talent (1994). The age of the fauna occurring high in the Boola Formation is poorly constrained, with successive revisions providing younger age estimates. Philip (1960) considered that elements of the brachiopod fauna from the upper 45 m of the unit indicated a Ludlow age but, following the revision of indicator taxa in Belgium (Boucot 1960), Philip (1962) dated the assemblage as early Lochkovian. Savage (1973) correlated the fauna with the early Lochkovian *Gypidula pelagica* brachiopod Biozone. Garratt (1983) assigned the fauna to the *australis* zone, inferring a late Lochkovian age, although he noted the presence of *Lissatrypa lenticulata*, considered an index species of the *loyolensis* zone elsewhere. Mawson & Talent (1994) suggested that the *australis* zone ranged into the lower parts of the *sulcatus* zone (earliest Pragian). A minimum age of the Boola Formation fauna is constrained by conodont assemblages from the base of the overlying Coopers Creek Limestone, correlated by Mawson & Talent with the upper part of the *Eognathodus sulcatus* conodont Biozone (early Pragian).

In considering the ranges of the 16 brachiopod and trilobite species that co-occur in the Lilydale fauna and the Tyers fauna, the strongest similarity of the Tyers fauna is with the faunal succession ranging in the 1 700 m – 2 400 m and 2 580 m – 2 600 m intervals of the Humevale Siltstone at Lilydale, in which 15 of the 16 species common to both sequences are represented (Fig. 3). Emphasis on the last appearance of *Lochkovella longisulcata* suggests correlation with the lower interval. Unfortunately, this broad biostratigraphic correlation of the faunas is of limited significance in the age estimate of the Tyers fauna, as the age of the Humevale Siltstone fauna also remains poorly constrained. Despite the recently revised generic assignments of taxa represented at Lilydale (Talent et al. 2001), limited reliance can be placed on age constraints derived from the stratigraphic ranges of individual brachiopod and trilobite genera. Specifically, several genera considered by Brice *et al.* (2000) and Chlupáč et al. (2000) to be significant in the recognition of stage boundaries occur at Lilydale, but are anomalous with respect to their documented ranges. There is a greater degree of accord in the age suggested by trilobite species considered closest to those at Lilydale. The trilobite *'Trimerus' lilydalensis* Gill, 1949 (appearing at the 1 755 m horizon) belongs to a species group ranging no lower than the late Lochkovian elsewhere, and most closely resembles the poorly known late Lochkovian *'Digonus' bostoviensis* Tomczykowa, 1975 from Poland. *Lochkovella longisulcata* (last appearance at the 2 400 m horizon) most closely resembles the type species *L. misera* (Barrande, 1852) from the late Lochkovian-basal Pragian of Europe. Shergold (1968) compared his new species *Acastella frontosa* (ranging 550 m – 3 700 m interval) with *A. patula* Hollard, 1963 from the early Lochkovian of Morocco, and compared specimens of *Acaste lokii* Edgecombe, 1993 (ranging 1 100 m – 1 700 m interval) with *A. dayiana* Richter & Richter, 1954 from the early Lochkovian of Germany. These comparisons support a late Lochkovian age for the 1 700 m-2 400 m interval of the Humevale Siltstone.

There has been ongoing debate on the nature of the boundary between the Boola Formation and the overlying Coopers Creek Limestone. Philip (1965, 1968) argued that sedimentary features at the base of the Coopers Creek Limestone indicated a significant hiatus with respect to the Boola Formation. However, Mawson & Talent (1994) reinterpreted these features as localised and cited other features to support the overall conformity of the units. Poor constraints on the age

of the Boola Formation accommodate these divergent interpretations of the nature of its upper boundary with the Coopers Creek Limestone at Tyers. The early Lochkovian and late Lochkovian age estimates suggest a earliest Pragian hiatus to underlying the base of the Coopers Creek Formation, whereas earliest Pragian age estimates support interpretation of the sequence as conformable. Perhaps the most compelling support for a late Lochkovian rather than early Pragian age for the Tyers fauna is provided not by faunal elements, but by close alignment of the suggested hiatus between the Boola Formation and the Coopers Creek Limestone with the 'pre-1A' eustatic regressive phase recognised across North America by Johnson & Sandberg (1988). This event is correlated with the *pesavis* zone-early *sulcatus* zone (latest Lochkovian-earliest Pragian) interval, and is documented elsewhere as the basal Pragian boundary event (Walliser *in* Weddige 1998; Chlupác & Kukal 1986).

SYSTEMATIC PALAEONTOLOGY

Trilobite specimens described here are preserved as internal and external moulds. For photography, internal moulds have been coated with colloidal graphite, external moulds have been prepared as latex peels, and all were whitened with ammonium chloride. Specimens housed in the Melbourne Museum are registered with the prefix NMV P. Trilobite localities cited in the text include localities registered at the Melbourne Museum (prefixed PL), Geological Survey of Victoria localities (prefixed GSV), G. Sweet localities (prefixed Y or YF) and E. D. Gill localities (prefixed G). These and other localities are mapped in Gill (1940, 1945), VandenBerg (1970), Garratt (1977) and Wall *et al.* (1995).

Order Phacopida Salter, 1864
Suborder Phacopina Richter, Richter & Struve, 1959
Superfamily Phacopoidea Hawle & Corda, 1847
Family Phacopidae Hawle & Corda, 1847
Subfamily Phacopinae Hawle & Corda, 1847

Genus *Lochkovella* Chlupác, 1972

Type species. Phacops miser Barrande, 1852 from the Lochkov Formation (Lochkovian, *hercynicus* Zone, Early Devonian), Lochkov, Czech Republic.

Species assigned. Reedops deckeri Delo, 1935; *Ananaspis ekphymus* Jones, Hall, Wright & Carr, 1986; *Phacops fecundus minor* von Gaertner, 1930; *Phacops grimbergi* Frech, 1888; *Phacops (Phacops?) hanusi* Chlupác, 1977; *Phacops heritschi* von Gaertner, 1930; *Acaste longisulcatus* Shergold, 1968; *Phacops (Phacops?) veles* Chlupác, 1972; *Kainops* sp. cf. *ekphymus* (*in* Ebach 2002); *Reedops* sp. nov. (*in* Holloway *in* Jell & Holloway 1983).

Range. Ludlow-Pragian.

Revised diagnosis. Glabella moderately convex, with front of glabella overhanging anterior border in dorsal view. Preoccipital ring as high as glabella anterior to L1. S2-S3 shallow to moderately deep. Eye placed with anterior margin adjacent to lateral border furrow. Glabellar ornament variable, ranging between moderately-sized tubercles to coarse granulation. Coarse to fine granulation on entire exoskeleton. Vincular furrow of variable depth, lateral notching indistinct. Hypostome inflated with middle furrow poorly defined, posterior border of moderate length. Pygidium with 6-7 deep pleural furrows that are uniform in depth to border, posterior furrows not markedly shallowed; interpleural furrows a well-defined incision, reaching border.

Discussion. Chlupác (1972) erected *Lochkovella* to accommodate species previously assigned to *Denckmannites*, restricting the latter to the type, *D. volborthi* (Barrande, 1852). Campbell (1977) regarded *Lochkovella* as a subgenus of *Denckmannites*, noting that both taxa share relatively narrow axial and wide pleural proportions that distinguish them from most other phacopids. Chlupác (1977) noted the rich segmentation of the pygidia shared by the two genera, and suggested possible derivation of *Lochkovella* from *Denckmannites*. This view was shared by Campbell, who considered the main difference between the groups to be the continuous anterior cephalic border of the latter. Chlupác (1977) listed further differences, including the greater convexity and forward projection of the glabella of *Lochkovella*, as well as its shorter hypostome and more distinct interpleural furrows. The differences between *Lochkovella* and *Denckmannites* are considered here to be profound and to support the full generic status of *Lochkovella*. *Denckmannites* is characterised by an unusually narrow glabella and an extraordinarily narrow pygidial axis (far narrower than those of *Lochkovella*), and large L1. Rich pygidial segmentation in the genera is manifestly different, in *Denckmannites* being expressed by a high number of pleural furrows (8 to 9) but in *Lochkovella* by well-

defined interpleural furrows (5 to 7). In addition, though the length of the eye is short in both *Lochkovella* and *Denckmannites*, the visual surface is differently developed, being highly reduced in *D. volborthi* but normally developed in *Lochkovella*. The similarities between these genera have been overstated and do not signify a close relationship. Rather, the specialised morphology of *Denckmannites* is analogous to that of other deep-water phacopids and reflects no more than adaption to the environment. Morphoclines involving eye length, pygidial segmentation and glabellar development recognised by Chlupác between *Denckmannites*, *Lochkovella* and *Reedops* are based on very generalised characters and do not indicate ancestor-descendant relationships as suggested by Campbell and Chlupác.

The concept of *Lochkovella* described in the revised diagnosis here is much wider than that of Chlupác (1977), and embraces a number of species previously assigned to *Reedops*, *Ananaspis*, *Phacops* and *Kainops*. *Lochkovella* differs from *Reedops* in having strongly expressed cephalic ornament that often extends over the entire exoskeleton, distinct S2-S3, and a lower cephalic length/width ratio (0.59 in *L. misera*; cf. 0.65-0.72 in *Reedops*). Chlupác described the glabella of *Lochkovella* as overhanging the anterior border, as in *Reedops*, although in glabellar profile the latter can be distinguished by its stronger inflation and, in some species, its more forward projection. In pygidial features *Lochkovella* can be easily distinguished from *Reedops* by the more robust appearance of the latter, being proportionally narrower and with a wider and more inflated axis, and with pleural furrows shallowing abruptly posteriorly with very weak to effaced interpleural furrows. Species previously assigned to *Reedops* include the Lochkovian *R. deckeri* Delo, 1935 from Oklahoma. Ormiston (1968) excluded *deckeri* from *Reedops* on the basis of its medially distinct vincular furrow. The depth of S2 and S3, the extensive granulate ornament and the depth and uniformity of pygidial pleural and interpleural furrows are also considered here as significant in distinguishing the species from that genus and in supporting assignment to *Lochkovella*. Similar features indicate that the closely comparable *Reedops* sp. nov. of Holloway *in* Jell & Holloway (1983) belongs to *Lochkovella*. The species occurs stratigraphically below *L. longisulcata* in the lowermost 100 m of the Humevale Formation at Christmas Hills. Associated faunal elements correlate with the *plentiensis* zone, considered here to span the late Ludlow-Pridoli. The species is distinguished in having a glabellar ornament of finer granules that extend, with little change in size or density, over the entire exoskeleton.

Although Campbell (1977) and Chlupác (1977) also suggested possible derivation of *Lochkovella* from *Ananaspis*, recognising strong resemblances in pygidial morphology, there has been very little other consideration given to the relationship between *Ananaspis* and *Lochkovella*. Chlupác did not explicitly compare *Lochkovella* with *Ananaspis*, and Campbell noted only that the glabellar shape of *Lochkovella* is more similar to *Ananaspis* than to *Reedops*. Ramsköld & Werdelin (1991) made no reference to *Lochkovella* in their cladistic analysis of Silurian-Early Devonian phacopids. In overall cephalic and pygidial morphology *Lochkovella* and *Ananaspis* are very similar, and the separation of the genera is not straightforward. Characters considered of significance in distinguishing *Ananaspis* include the presence of vincular notching (indistinct in *Lochkovella*), more proximally and higher-placed eyes (antero-laterally placed eyes in *Lochkovella*), a librigenal field separating the eye from the lateral border furrow (absent in *Lochkovella*) and more deeply incised interpleural furrows (shallower in *Lochkovella*). Emphasis on the lateral notching of the vincular furrow and the proximal placement of the eyes is justified by their conservative expression in presumably descendant groups of *Ananaspis* including *Paciphacops* and *Echidnops*. Morphology of the hypostome is another way of distinguishing the genera, although information is available for few species; the hypostome of *L. misera* exhibits a long posterior border, whereas in *A. fecundus* (and *Echidnops* and *Paciphacops*) it exhibits a short posterior border.

Species previously assigned to *Ananaspis* include the Lochkovian *A. ekphymus* Jones, Hall, Wright & Carr, 1986 from Bungonia, New South Wales. Ramsköld & Werdelin (1991) considered *A. ekphymus* to be conspecific with *Paciphacops (Paciphacops) microps* Chatterton, Johnson & Campbell, 1979 from the Pragian of Wellington, New South Wales, nominated as the type species of their new genus *Kainops*. However, *ekphymus* can be distinguished in having much denser and more uniformly sized cephalic and post-cephalic tuberculation, a vincular furrow that is almost indistinct medially, and a shorter eye and longer postocular genae (postocular length/eye length 0.6 in *ekphymus*; cf. 0.5 in *microps*). These differences are in accord with its assignment to *Lochkovella*. Following Ebach (2002), *ekphymus* is maintained here as an independent species. Ebach documented a species close to *ekphymus* from the Lochkovian-?Pragian at Cobar, New South Wales. The species differs from *ekphymus* in having much smaller cephalic tubercles and an even longer postocular genal length (eye length/postocular

genal length 0.7-1.0).

Species previously assigned to *Phacops* include two Pragian Czech species described by Chlupác (1977) as *Phacops (Phacops?) hannsi* and *P. (P?) veles*. Chlupác considered that these species represent morphologies intermediate between *Ananaspis* and *Phacops* and show some similarities to *Reedops*, and they were more recently placed in *Kainops* by Ramskold & Werdelin (1991). The finely tuberculate ornament of the exoskeleton, the well-defined pygidial segmentation and the antero-lateral placement of the eye indicate assignment to *Lochkovella*. In the low contrast between cephalic and post-cephalic ornament, these species are closest to *L. deckeri* and the species from Cobar and Christmas Hills.

Species previously assigned to *Lochkovella* by ChlupáC (1977) but excluded here include two species figured by Alberti (1970), *Phacops (Reedops)* sp. A aff. *akouchensis* (G. & H. Termier, 1950) and *Phacops (Reedops)* sp. B aff. *akouchensis*, both from Morocco. With further material Alberti (1983) redescribed these as species of *Phacops (Prokops). Denckmannites rutherfordi* Sherwin, 1968 from the Late Silurian Wallace Shale of New South Wales is also excluded from *Lochkovella*, differing from assigned species in having strongly defined notches on the vincular furrow.

Lochkovella longisulcata (Shergold, 1968)

Fig. 4A-S, Fig. 5A-S

1876 *Phacops (Portlockia) fecundus* (Barrande); McCoy, p. 15-16, pl. 22, figs 8-9; pl. 23, figs 2-3, *non* pl. 23, figs 1, 4-6 (= *Nephranomma debrae* Sandford, 2003).

1896 *Phacops sweeti* Etheridge & Mitchell, p. 497 (*non* figs = *Nephranomma sweeti* Etheridge & Mitchell, 1896).

1915 *Phacops crossleii*; Chapman, p. 168, pl. 15, fig. 15 *non* fig. 14 (= *Acaste lokii* Edgecombe, 1993)

1938 *Phacops fecundus*; Gill, p. 170 (pars).

1940 *Phacops fecundus* McCoy *non* Barrande; Gill, p. 250 (pars).

1951 *Phacops* sp. nov.; Gill, p. 31 (pars).

1968 *Acaste longisulcata* Shergold; p. 20, pl. 4, figs 7-8 *non* pl. 5, figs 1-12 (= *Acaste lokii* Edgecombe, 1993).

1996 *Ananaspis* sp. 1; Sandford, p. 220, pl. 26, figs A-H, *non* fig. 1 (=*Ananaspis* sp.)

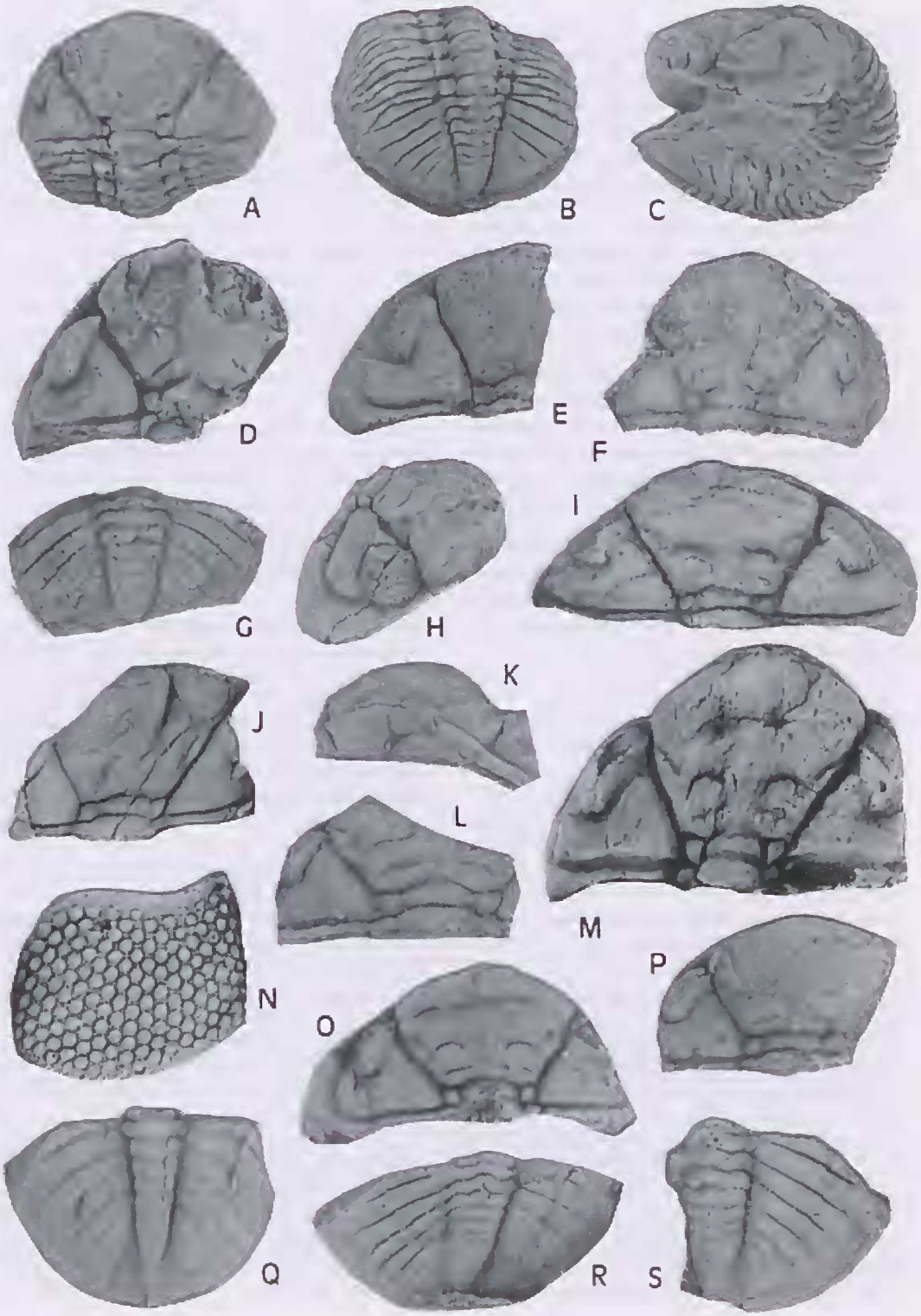
Type material. Holotype P12680 (pygidium, figured Chapman 1915: pl. 15, fig. 15, figured Shergold 1968: pl. 4, figs 7-8) from PL1820 (G20, *'Ruddocks Quarry'*), Chirnside Park. The paratypes of *Acaste longisulcata* including P25230-38, P25240 (all from PL1850 (G50, *'Black Springs Quarry'*), Chirnside Park form the type series of *Acaste lokii* Edgecombe, 1993.

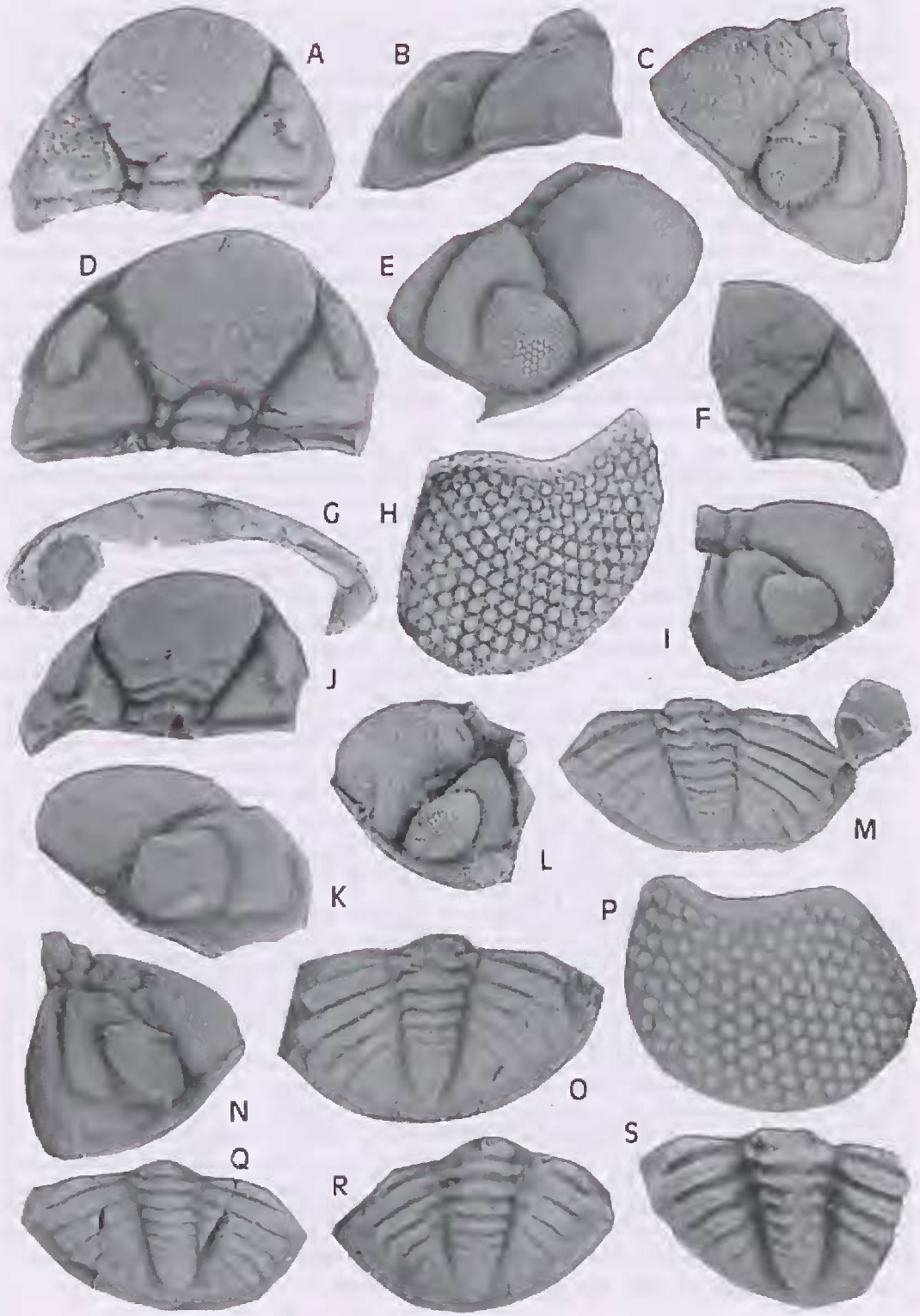
Figured specimens. P12118 (enrolled exoskeleton, figured McCoy 1876: pl. 23, figs 2, 3) from PL1804 (GSV B15, *'Section 12, Parish of Yering'*) Coldstream, considered by Gill (1940) the same locality as G4, *'Flowerfield* (or *Mic Blacks) Quarry'*. The cephalon and the pygidium figured by McCoy (1876: pl. 22, fig. 8, fig. 9 respectively) are missing but, from his illustrations they can also be confidently attributed to *L. longisulcata*.

Other material. 100 specimens: four exoskeletons, 39

Fig. 4. Lochkovella longisulcata (Shergold, 1968). A-C. P79123, enrolled exoskeleton, internal mould. A, dorsal view of cephalon x 1.0. B, lateral view x 1.25. C, dorsal view of pygidium x 1.0. D. Topotype P306868, cephalon, internal mould, dorsal view x 2.8. E. P12117, cephalon, internal mould, dorsal view x 1.6. F. P12118, cephalon, latex cast, dorsal view x 1.4. G. P306751, pygidium, internal mould, dorsal view x 1.8. H. P308933, cephalon, internal mould, oblique view x 1.75. I. P306919, cephalon, internal mould, dorsal view x 1.8. J. P308920, cephalon, latex cast, dorsal view x 3.0. K. P308925, cephalon, internal mould, ventral view (doublure) x 2.0. L. P306750, cephalon, latex cast, dorsal view x 2.3. M. P137147, cephalon, internal mould, dorsal view x 2.5. N. P308931, cephalon, latex cast, enlargement of eye x 9.0. O. P308919, cephalon, internal mould, dorsal view x 1.8. P. P308924, cephalon, internal mould, dorsal view x 2.2. Q. P308926, pygidium, latex cast, dorsal view x 2.4. R. P308928, pygidium, latex cast, dorsal view x 2.5. S. P308930, pygidium, latex cast, dorsal view x 2.5. A-G, I, M from the Humevale Siltstone. H, J-L, N, S from the Boola Formation.

Fig. 5. Lochkovella longisulcata (Shergold, 1968). A, I. P306914, cephalon, internal mould x 4.5. A, dorsal view. I, lateral view. B, C, F, H, N. P306875, cephalon. B, internal mould, anterior view x 2.75. C, latex cast, oblique view x 2.75. F, internal mould, dorsal view x 2.25.H, latex cast, enlargement of eye x 9.0. N, latex cast, lateral view x 2.75. D, E, M, P. Topotype P306864, partly enrolled exoskeleton. D, internal mould, dorsal view of cephalon and first thoracic segment x 3.3. E, latex cast, oblique view of cephalon x 4.0. M, internal mould, lateral view of cephalon x 4.4. P, latex cast, enlargement of eye x 12. G. Topotype P306867, cephalon, latex cast, ventral view (doublure) x 3.0. J. P306876, cephalon, internal mould, dorsal view x 3.7. K, L. P306872, cephalon. K, latex cast, oblique view x 5.0. L, external mould adjacent to large pygidium x 2.0. M. P306871, pygidium, internal mould, dorsal view x 2.0. O. P306916, pygidium, internal mould, dorsal view x 2.4. Q. Topotype P306865, pygidium, internal mould, dorsal view x 2.0. R. Holotype P12680, pygidium, internal mould, dorsal view x 2.5. S. P306877, pygidium, internal mould, dorsal view x 3.0. Humevale Siltstone.


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S

cephala, one partly disarticulated thoracopygon, 56 pygidia. *Chirnside Park-Coldstream area:* Topotypes P306864-70 from PL1820. P137147-9, P140153 probably from PL1820. Unregistered specimen from PL1839 (G39, *'North of Ruddocks'*), Chirnside Park. P306890-1 from PL1817 (G17, *'Black Springs Cutting'*), Chirnside Park. P306916-17 from locality RHR (corner of Brentwoods and Rolling Hills Road), Chirnside Park. P26089 from PL1891 (G91), Chirnside Park. P79214, P306871-2, P306875-85, P306887-89 from PL6751, Chirnside Park. P306914-15 from PL1892 (G92), Chirnside Park. P306753-7, P306764 from PL1804 (YF, *'Yarra Flats'*). P306758 from PL1804 (Y, *'Yering'*). P12117, P306750-1, P306759 from PL1804 (GSV B15). P79123 from PL1804 or PL1805 (G5, *'Flowerfield Cutting'*), Coldstream. *Mooroolbark area*: P306919-20, P306986 from locality BW6 (corner of Winyard Drive and Baradine Road), Mooroolbark. *Tyers area:* P308919, P308953-4 from PL337, Tyers. P308920-8, P308939-50 from PL334, Tyers. P308929 (ex GSV 19377), P308952 from *'Tyers River'* (exact locality unknown). P308930-1 from *'Tyers'* (exact locality unknown). P308955 from *'near Tyers Quarry'* (exact locality unknown). *Coopers Creek area:* P308956 from PL1797, Coopers Creek. P308933-4 from *'Coopers Creek'* (exact locality unknown). P308951 from Evans Brothers Quarry, Coopers Creek.

Revised diagnosis. Lochkovella with anterior margin of glabella broadly rounded, with arc of curvature centred at about 0.25 cephalic length. Axial furrows weakly sinusoidal. Eye large for genus, length (exsag.) 0.37 times cephalic length, with midline placed opposite 0.53 cephalic length. Visual surface with 17-25 (mostly 18-21) lens files of up to 7-10 lenses per file and between 105-180 lenses. Postocular genal length (exsag.) 0.25 times cephalic length and 0.7 times length of eye (ranging to 0.2 times cephalic length and 0.4 times eye length in smaller specimens). Glabellar tuberculation comprising small, sparsely to densely distributed tubercles interspersed with dense ornament of granules, granulation coarser anteriorly, tubercles larger posteriorly. Palpebral area and postocular genae with subdued tuberculation. Vincular furrow indistinct medially, without notching laterally. Pygidium with 7-9 axial rings, 6-7 pleural ribs. Cephalic doublure and pygidium with ornament of fine granulation.

Description. Estimated maximum length 9 cm (based on specimen P79123). Cephalon roughly semicircular in dorsal outline, length about 0.56 times width. In anterior view glabella moderately convex, in lateral view, dorsal outline weakly convex posteriorly, strongly convex anteriorly, with anterior surface of glabella vertical. Glabellar length about equal to maximum width, anterior to occipital furrow expanding strongly forwards with maximum width about 0.6 times cephalic width and about 1.75 times occipital width, maximum glabellar width placed opposite 0.75 cephalic length. Occipital ring width 0.35 times cephalic width, length (sag.) 0.13 times cephalic length, with deep longitudi-

SPECIMEN	CEPHALIC LENGTH	LENS FORMULA		TOTAL LENSES	TOTAL FILES
P306872	5.5 mm	5 6 7 7 7 8 7 7 6 7 7 6 7 6 5 6 6 5 4 3 2		124 lenses	21 files
P306914	7 mm	. . 8 8 7 8 7 8 9 9 9 8 8 8 7 7 6 5 4 2		~140 lenses	20 files
P306876	7.5 mm	6 7 9 # # # # # # # #			21 files
P306867	9 mm	5 7 7 7 7 7 7 7 7 7 . . . . 6 6 4 3		~115 lenses	18 files
P306864	10 mm	5 7 7 8 8 8 8 8 8 8 8 8 8 7 7 6 5 4 1	right eye	129 lenses	19 files
		. . 8 8 8 9 9 8 8 8 8 6 6 6 7 6 5 4 2	left eye	~129 lenses	19 files
P306891	10 mm	4 6 6 6 7 7 7 8 8 8 7 7 6 6 5 5 2		105 lenses	17 files
P306868	11 mm	4 5 7 7 7 7 7 8 8 8 7 7 6 7 6 6 5 4		116 lenses	18 files
P306875	12 mm	5 7 8 9 9 # # # 9 9 9 8 9 9 9 8 7 7 5 5 3		165 lenses	21 files
P306919	13 mm	4 6 8 8 8 9 . . . . . 8 7 6 5 6 5 3 2		~135 lenses	20 files
P137149	13 mm	. . . . . 9 9 8 9 9 8 8 8 7 6 5 3 1			25 files
P308931		3 7 8 9 # 9 # 9 # 9 9 9 8 8 7 8 8 7 8 8 4 3 1		172 lenses	23 files
P306754	14 mm	6 7 7 8 9 9 9 # # # # # 9		~160 lenses	20 files
P306869	~15 mm	5 7 8 8 9 8 9 8 9 8 8 7 7 7 6 5 5 3		127 lenses	18 files
P137147	~15 mm	6 7 8 9 # # 9 # # 8 9 8 9 9 ? ? ? ? ? 7 6 5		~180 lenses	22 files
P306752	17 mm	. . . . . 8 9 8 9 8 8 7 8 8 . . . . 4 2			20? files

Table 1. Visual surfaces of specimens of *Lochkovella longisulcata* (Shergold, 1968).

nal furrow impressed into anterior margin of occipital ring opposite L1 and continuing across occipital ring as moderately impressed furrow, defining lateral occipital lobes, length (exsag.) of lobes about 0.5 times sagittal length of occipital ring. Medial section of occipital furrow transverse, and moderately impressed, short (sag.) on external surface, longer on internal moulds, lateral section offset (posteriorly), directed antero-laterally (at about 20° to the transverse) and deep. Medial section of pre-occipital ring with length about 0.07 times cephalic length, length 0.25 times width, in lateral view at same height as glabella anterior to L1. L1 isolated from preocciptal ring by longitudinal furrow, deep at anterior margin of ring and moderately impressed posteriorly. L1 quadrate, flat, length of L1 (exsag.) 0.1 cephalic length. L1-L1 0.9 times occipital width. S1 deep and transverse, continuous with preocciptal furrow that is shallow and long (sag.).

Eye oriented at about 20° to the saggital line. Visual surface with highly variable lens count, with 17-25 (mostly 18-21) lens files of up to 7-10 lenses per file and between 105-180 lenses in total (see Table 1). Palpebral lobe crescentic, length (exsag.) 0.3 times cephalic length, narrow (width at midlength about 0.2 times length), with prominent palpebral rim and distinct palpebral rim furrow, δ?δ 0.8 times cephalic width and 1.35 times glabellar width. Palpebral furrow moderately impressed, shallowing opposite palpebral midlength, continuous with deep postocular furrow. Sclera not raised. Anterior half of eye extending to librigenal border furrow, librigenal field poorly defined as a small depressed triangular area bounded by postero-lateral margin of eye, lateral border furrow and facial suture. Lateral border narrow and concave anteriorly, markedly widening posterior to midlength of eye, with shallow epiborder furrow extending to the point where the facial suture crosses the lateral margin. Cephalic doublure with sagittal length about 0.3 times cephalic length. Hypostomal suture transverse, with moderate median sag in anterior view.

Thoracic axial rings with strongly defined, quadrate, flat lateral nodes.

Pygidium lenticular in outline, with length about 0.5 times width, weakly convex. Axis raised, width 0.27 times pygidial width, moderately tapering, sides converging posteriorly at about 22°, reaching to 0.95 pygidial length, triangular terminal piece. First axial ring with well defined pseudo-articulating half-ring impressed into posterior margin, poorly defined on second and third rings, indistinct posteriorly. Interpleural furrows shallow but distinct. Pleural furrows deep and wide, shallowing abruptly adjacent to margin, lateral border furrow and border poorly defined. Axial rings with coarse granulation. Pygidial doublure narrow, steeply inclined laterally, sub-vertical posteriorly, strongly convex in section.

Glabellar tuberculation comprising small, sparsely to densely distributed tubercles interspersed with dense ornament of granules, granulation coarser anteriorly, tubercles larger posteriorly. Palpebral area and postocular genae with subdued tuberculation. Fine granulation on remainder of exoskeleton.

Remarks. McCoy's (1876) description of '*Phacops (Portlockia) fecundus* Barrande, 1846' from Coldstream is based predominantly on specimens of *Lochkovella longisulcata*, and he listed a number of characters that are in accord with its assignment to *Lochkovella* including the long postocular genal length, the weak glabellar tuberculation, the granular surface ornament and the definition of the pygidial pleural and interpleural furrows. Etheridge & Mitchell (1896) referred McCoy's Coldstream specimens together with specimens from Loyola to their new species *Phacops sweeti*. However, Gill (1938) considered that the high lens counts of the Loyola specimens (22 rows, up to 12 lenses per row) distinguished them from the Coldstream specimens. Gill (1951) considered the latter represented one and possibly two new species, conclusions confirmed by their subsequent assignment to *Nephranomma debrae* Sandford, 2003 and *L. longisulcata*. Gill pre-empted the assignment of McCoy's specimens to *Lochkovella* in noting the morphology was intermediate between *Reedops* and *Phacops*, and close to *R. deckeri*.

Lochkovella longisulcata is closest to *L. misera*. These species differ from the *deckeri* group in exhibiting a distinct contrast in the grade of cephalic and postcephalic ornament, a contrast stronger in *L. longisulcata*. In this respect these species are closest to *Ananaspis*. *Lochkovella longisulcata* further differs from the type species in having a slightly more broadly rounded glabellar anterior margin, sinusoidal rather than straight axial furrows; a larger eye (17-21, rarely 23-25 files of up to 7-10 lenses per file, see Table 1, cf. 13-14 files of up to 6 lenses per file in *L. misera*) that is more forwardly placed (anterior margin of eye opposite 0.7 rather than 0.65 cephalic length); glabellar tubercles that are slightly bigger and extend onto the genal areas, and finer interspersed granulation; and shallower pleural furrows posteriorly.

Variation within the populations assigned to *Lochkovella longisulcata* is considerable. Glabellar tuberculation ranges in density from sparse to dense and in size from small tubercles to coarse granules.

Tubercles on the smallest specimens are most prominent, as might be expected. More difficult to explain is the distinctly subdued ornament on specimens of both *L. longisulcata* and *Nephranomma debrae* in sandstone at PL1804 compared to specimens in siltstone at other localities; the differences appear to be real and cannot be attributed to preservation in a sandier matrix. Variation in glabellar ornament occurs between individuals from the same locality, but variations in eye size and lens arrangement appear to occur between populations from different localities. Specimens from the Tyers-Coopers Creek area have slightly shorter eyes/longer postocular genae than those from the Lilydale sequence, whereas those from the PL6751 (Coldstream) have somewhat longer eyes/shorter postocular genae than those from other localities. As there are no other consistent differences in degree of tuberculation, eye lenticulation or pygidial segmentation that further distinguish the various populations of *L. longisulcata*, they are considered to reflect natural intraspecific variation.

Lochkovella longisulcata occurs with *Nephranomma debrae* at several localities between the 1 750 m and 2 400 m horizons of the Humevale Siltstone. The two species are similar in overall appearance, but can always be distinguished by the shorter postocular genal length and larger eye in *N. debrae*. In addition, in *N. debrae* the glabellar tubercules are generally coarser; its eyes have higher lens counts (160-183 lenses in 10-11 files) and are placed more or less in exsagittal orientation; its cephalic doublure is more coarsely ornamented; and its pygidium is less deeply furrowed and only has five pleural furrows.

Four cephala erroneously documented from the Late Wenlock-Early Ludlow Yan Yean Formation and previously described as *Ananaspis* sp. 1 (Sandford 1996) belong to *L. longisulcata*. The lithology and preservation of the specimens most closely matches that of the type locality PL1820, (G20, *'Ruddocks Quarry'*) from where they were probably collected.

ACKNOWLEDGMENTS

The author is most appreciative of improvements to the manuscript suggested by Dr A. J. Wright (University of Wollongong) Dr Stephen Gallagher (University of Melbourne) and Dr David Holloway (Melbourne Museum). The manuscript was prepared with support from a David Hay Postgraduate Award.

REFERENCES

Alberti, G. K.B., 1970. Trilobiten des jüngeren Siluriums sowie des Unter- und Mitteldevons. 2. *Abhandlungen der senekenbergischen naturforschenden Gesellschaft* 525: 1-233.

Alberti, G. K.B., 1983. Trilobiten des jüngeren Siluriums sowie des Unter- und Mittel-Devons. 4. *Senekenbergiana lethaea* 64: 1-87.

Boucot, A.J., 1960. Lower Gedinnian brachiopods of Belgium. *Louvain Institut géologique Mémoire* 21: 283-324.

Barrande, J., 1846. *Notice préliminaire sur le Système silurien et les trilobites de Bohême*. C.L. Hirschfeld, Leipzig, vi + 97 pp.

Barrande, J., 1852. *Système silurien du centre de la Bohême. 1ère partie. Recherches paléontologiques, vol. 1. Crustacés, Trilobites*. Prague and Paris, 935 pp., 51 pls.

Brice, D., Carls, P., Cocks, L.R.M., Copper, P., Garcia-Alcalde, J.L., Godefroid, J. & Racheboeuf, P.R., 2000. Brachiopoda, In *Subcommision on Devonian Stratigraphy. Fossil groups important for boundary definition*, P. Bultynck, ed., *Courier Forschungsinstitut Senckenberg* 220, 65-86.

Campbell, K.S.W., 1977. Trilobites of the Haragan, Bois d'Arc and Frisco formations (Early Devonian) Arbuckle Mountains Region, Oklahoma. *Bulletin of the Oklahoma Geological Survey* 123: 1-221.

Chapman, F., 1915. New or little-known Victorian fossils in the National Museum. Part 18. Some Yeringian trilobites. *Proceedings of the Royal Society of Victoria* 28: 157-171.

Chatterton, B. D. E., Johnson, B. D. & Campbell, K. S. W. 1979. Silicified Lower Devonian trilobites from New South Wales. *Palaeontology 22*, 799-837.

Chlupáč, I., 1972. New Silurian and Devonian phacopid trilobites from the Barrandian area (Czechoslovakia). *Casopis pro mineralogii a geologii* 17: 395-401.

Chlupáč, I., 1977. The phacopid trilobites of the Silurian and Devonian of Czechoslavakia. *Rozpravy Ústredního Ústavu Geologického* 43: 1-172.

Chlupáč, I., Feist, R. & Morzadec, P., 2000. Trilobites and standard Devonian stage boundaries. In *Subcommision on Devonian Stratigraphy. Fossil groups important for boundary definition*. Bultynek, P. (ed.). *Courier Forschungsinstitut Senckenberg* 220, 87-98.

CHLUPÁC, I. & KUKAL, Z. 1986. Reflection of possible global Devonian events in the Barrandian area, C. S. S. R., In *Global Bioevents. Lecture Notes in Earth Sciences* 8, Walliser, O. H. (ed). Springer, Heidelberg, 171-179,.

DELO, D.M., 1935. A revision of the phacopid trilobites. *Journal of Paleontology* 9: 402-420.

EBACH, M.C., 2002. Lower Devonian trilobites from Cobar, New South Wales. *Records of the Western Australian Museum* 20: 353-378.

EDGECOMBE, G.D., 1993. Silurian acastacean trilobites of the Americas. *Journal of Paleontology* 67: 535-548.

ETHERIDGE, R. & MITCHELL, J., 1896. The Silurian trilobites of New South Wales, with references to those of other parts of Australia. Part 3. The Phacopidae. *Proceedings of the Linnean Society of New South Wales* 20: 486-511.

ETHERIDGE, R. & MITCHELL, J., 1917. The Silurian trilobites of New South Wales, with references to those of other parts of Australia. Part 6. The Calymenеidae, Cheiruridae, Harpeidae, Bronteidae, & c., with an appendix. *Proceedings of the Linnean Society of New South Wales* 42: 480-510.

FRECH, F., 1888. Über das Devon der Östalpen, nebst Bemerkungen über das Silur und einem paläontologischen Anhang. *Zeitschrift der Deutschen geologischen Gesellschaft* 39: 44.

GAERTNER, H.R. von., 1930. Silurische und tiefunterdevonische Trilobiten und Brachiopoden aus den Zentralkarnischen Alpen. *Jahrbuch Preussischen geologischen Landesanstalt zu Berlin* 51: 188-249.

GARRATT, M.J., 1977. *Kinglake 1:63,000 geological map*. Department of Mines, Melbourne.

GARRATT, M.J., 1983. Silurian and Devonian biostratigraphy of the Melbourne Trough, Victoria. *Proceedings of the Royal Society of Victoria* 95: 77-98.

GARRATT, M. J. & WRIGHT, A.J., 1988. Late Silurian to early Devonian biostratigraphy of southeastern Australia, In *Devonian of the World. Proceedings of the Second International Symposium on the Devonian System, Calgary, Canada. Volume III. Paleontology, Paleoecology and Biostratigraphy.* McMillan, N. J., Embry, A. F. & Glass, D. J. (eds). Memoir 14. Canadian Society of Petroleum Geologists, Calgary, Alberta, Canada, 647-662.

GILL, E.D., 1938. Yeringian trilobites. *Victorian Naturalist* 54: 167-171.

GILL, E.D., 1940. The Silurian Rocks of Melbourne and Lilydale: a discussion of the Melbournian-Yeringian boundary and associated problems. *Proceedings of the Royal Society of Victoria* 52: 249-261.

GILL, E.D., 1945. Trilobita of the Family Calymenidae from the Palaeozoic rocks of Victoria. *Proceedings of the Royal Society of Victoria* 56: 171-186.

GILL, E.D., 1948. A gens of dalmanitid trilobites. *Journal and Proceedings of the Royal Society of New South Wales* 82: 16-24.

GILL, E.D., 1949. Some Australian homalonotid trilobites. *Proceedings of the Royal Society of Victoria* 61: 61-74.

GILL, E.D., 1951. Revision of McCoy's 'Prodromus' types from the Lilydale and Killara districts of Victoria. *Proceedings of the Royal Society of Victoria* 63: 31-38.

HAWLE, I. & CORDA, A.J.C., 1847. Prodrom einer Monographie der böhmischen Trilobiten. J. G. Calve, Prague, 176 pp.

HOLLARD, H., 1963. Les *Acastella* et quelques autres Dalmanitacea du Maroc présaharien. Leur distribution verticale et ses consequences pour l'étude de la limite Silurien-Dévonien. *Notes et Mémoires du Service Géologique du Maroc* 176: 1-66.

HOLLOWAY, D.J. & NEIL, J.V., 1982. Trilobites from the Mount Ida Formation (Late Silurian-Early Devonian), Victoria. *Proceedings of the Royal Society of Victoria* 94: 133-154.

JELL, P.A. & HOLLOWAY, D.J., 1983. Devonian and ?Late Silurian palaeontology of the Winneke Reservoir site, Christmas Hills, Victoria. *Proceedings of the Royal Society of Victoria* 95: 1-21.

JOHNSON, J.G. & SANDBERG, C.A., 1988. Devonian eustatic events in the western United States and their biostratigraphic responses, In *Devonian of the World. Proceedings of the Second International Symposium on the Devonian System, Calgary, Canada. Volume III. Paleontology, Paleoecology and Biostratigraphy.* N.J. McMillan, A.F. Embry Jr & D.J. Glass, eds, Memoir 14. Canadian Society of Petroleum Geologists, Calgary, Alberta, Canada, 171-178.

JONES, B.G., HALL, C.G., WRIGHT, A.J. & CARR, P.F., 1986. The geology of the Bungonia-Windellama area, New South Wales. *Proceedings of the Linnaean Society of New South Wales* 108: 267-286.

MCCOY, F., 1876. *Prodromus of the palaeontology of Victoria; or figures and descriptions of Victorian organic remains. Decade 3.* Geological Survey of Victoria, Melbourne, 40 pp., pls 21-30.

MAWSON, R. & TALENT, J.A., 1994. Age of an Early Devonian carbonate fan and isolated limestone clasts and megaclasts, east-central Victoria. *Proceedings of the Royal Society of Victoria* 106: 31-70.

ORMISTON, A.R., 1968. Lower Devonian trilobites of Hereynian type from the Turkey Creek inlier, Marshall County, south-central Oklahoma. *Journal of Paleontology* 42: 1186-1199.

PHILIP, G.M., 1960. Victorian Siluro-Devonian faunas and correlations. *International Geological Congress, Report of Twenty-first Session, Norden* 7: 143-157.

PHILIP, G.M., 1962. The palaeontology and stratigraphy of the Siluro-Devonian sediments of the Tyers area, Gippsland, Victoria. *Proceedings of the Royal Society of Victoria* 75: 123-246.

PHILIP, G.M., 1965. Lower Devonian conodonts from the Tyers area, Gippsland, Victoria. *Proceedings of the Royal Society of Victoria* 79: 95-117.

PHILIP, G.M., 1968. Late Silurian-early Devonian relationships in the central Victorian and western Tasmanian elastic sequences, Australia. In *International Symposium on the Devonian System, Calgary, volume 2.* Oswald, D. H. (ed.). Alberta Society of Petroleum Geologists, Calgary, 913-920.

RAMSKÖLD, L. & WERDELIN, L., 1991. The phylogeny and evolution of some phacopid trilobites. *Cladistics* 7: 29-74.

RICHTER, R. & RICHTER, E., 1954. Die Trilobiten des Ebbe-Sattels und zu vergleichende Arten (Ordovizium, Gotlandium/Devon). *Abhandlungen der Senekbergisehen, Naturforschenden Gesellschaft,* 488: 1-76.

RICHTER, R., RICHTER, E. & STRUVE, W., 1959. Suborder Phacopina, In *Treatise on invertebrate paleontology, Part O, Arthropoda 1.* R.C. Moore, ed., Geological Society of Americea and University of Kansas Press, Boulder, Colorado and Lawrence, Kansas,454-461

SALTER, J.W., 1864. A monograph of the British trilobites from the Cambrian, Silurian and Devonian formations. Part 1. *Monograph of the Palaeontographical Society*, 1-80.

SANDFORD, A.C., 1996. *Silurian trilobites of central Victoria.* MSc thesis, University of Melbourne, 320 pp.

SANDFORD, A.C., 2003. A revision of *Nephranomma* Erben, 1952 (Trilobita, Phacopidae), with new species from the Early Devonian of Victoria, Australia. Phacopidae of Victoria, Part 2. *Special Papers in Palaeontology* 70: 309-329.

SAVAGE, N.W., 1973. Lower Devonian biostrat-igraphic correlation in eastern Australia and western North America. *Lethaia* 5: 341-348.

SHERGOLD, J.H., 1968. On the occurrence of the trilobite genera *Aeaste* and *Aeastella* in Victoria. *Proceedings of the Royal Society of Victoria* 81: 19-30.

SHERWIN, L., 1968. *Denckmannites* (Trilobita) from the Silurian of New South Wales. *Palaeontology* 11: 691-6.

TALENT, J.A., GRATSIANOVA, R.T. & YOLKIN, E.A., 2001. Latest Silurian (Pridoli) to Middle Devonian (Givetian) of the Asia-Australia hemisphere: rationalisation of braehiopod taxa and faunal lists; stratigraphie correlation ehart. *Courier Forsehungsinstitut Senekenberg* 236: 1-121.

TERMIER, G. & TERMIER, H. 1950. *Paléontologie marocaine. Tome 2. Invertébrés de l'ère primaire. Faseieule 4. Annélides, arthropods, eehinoderms, eonularides et graptolites.* Hermann & Cie, Paris, 279 pp.

TOMCZYKOWA, E. 1975. The trilobite subfamily Homalonotinae from the Upper Silurian and Lower Devonian of Poland. *Aeta Palaeontologiea Polonica* 20: 1-46.

VANDENBERG, A.H.M., 1970. *Ringwood 1:63,000 Geologieal Map.* Department of Mines, Melbourne.

WALL, R., MAWSON, R., TALENT, J.A. & COOPER, B.J., 1995. Conodonts from an environmentally hostile context, the Lilydale Limestone (Early Devonian: Pragian) of eentral Vietoria. *Courier Forsehungsinstitut Senekenberg* 182: 371-387.

WEDDIGE, K. 1998. Devon-Korrelationstabelle. *Senekenbergiana lethaea* 77: 289-326.

Manuscript received 15 September 2002
Revision aceepted 10 July 2003